

# EARTH SCIENCES (ERTH)

## ERTH 110 Our Dynamic Earth (Units: 3)

Prerequisite: Not open to students who have completed ERTH 112.

Investigating the geologic processes that are continually shaping our planet, emphasizing the connections between humans and nature and the process of scientific discovery. Designed for non-science majors.

### Course Attributes:

- B1: Physical Science
- Environmental Sustainability

## ERTH 112 Our Dynamic Earth Lecture and Lab (Units: 4)

Prerequisite: Not open to students who have completed ERTH 110 or ERTH 111.

Investigate the geologic processes that are continually shaping our planet with an emphasis on the connections between humans and nature and the process of scientific discovery. Designed for non-science majors. Lecture, 3 units; laboratory, 1 unit. Extra fee required.

### Course Attributes:

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

## ERTH 115 History of Life (Units: 3)

Origin and early development of life; evolution of life through geologic time; extinction and replacement of organisms.

### Course Attributes:

- B2: Life Science
- Environmental Sustainability

## ERTH 162 Our Dynamic Weather Lecture and Lab (Units: 3)

Prerequisite: Not open to students who have completed ERTH 160.

The nature of weather, including winds, storms, clouds, and precipitation. How and why weather changes, emphasizing the process of scientific discovery. Weather map interpretation and weather forecasting. Designed for non-science majors. Lecture, 2 units; laboratory, 1 unit.

### Course Attributes:

- B1: Physical Science
- B3: Lab Science

## ERTH 170 Our Dynamic Ocean (Units: 3)

Prerequisite: Not open to students who have completed ERTH 172.

Investigating components and operating principles of the ocean system, including ocean basin features, currents, nutrient cycling, and climatic influences, emphasizing the process of scientific discovery. Designed for non-science majors.

### Course Attributes:

- B1: Physical Science
- Environmental Sustainability

## ERTH 171 Our Dynamic Ocean Lab (Unit: 1)

Prerequisite: ERTH 170 (may be taken concurrently); not open to students who have completed ERTH 172.

Investigating ocean processes that play a dominant role in regulating our climate and environment. Emphasizes nature human connections and the process of scientific discovery through hands-on activities. Extra fee required.

### Course Attributes:

- B3: Lab Science

## ERTH 172 Our Dynamic Ocean Lecture and Lab (Units: 4)

Prerequisite: Not open to students who have completed ERTH 170 or ERTH 171.

Investigate components and operating principles of the ocean system, including ocean basin features, currents, nutrient cycling, and climatic influences, emphasizing the process of scientific discovery. Designed for non-science majors. Lecture, 3 units; laboratory and fieldwork, 1 unit. Extra fee required.

### Course Attributes:

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

## ERTH 205 Techniques in Earth Sciences (Units: 2)

Prerequisite: An introductory course in one of the earth sciences (geology, meteorology, oceanography) or ERTH 400.

Introduction to field and laboratory techniques in the earth sciences, including scientific writing and library research. Laboratory and fieldwork, 2 units. (Plus-Minus letter grading only)

## ERTH 210 Physical Geology (Units: 4)

Composition, structure, and evolution of the earth; earth materials; tectonic and hydrologic systems; landform development; relation of geologic systems to the human environment. Lecture, 3 units; laboratory and fieldwork, 1 unit. Extra fee required. (Plus-minus letter grade only)

### Course Attributes:

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

## ERTH 230 Environmental Geology (Units: 3)

Human interaction with the geologic environment. Social and political implications, resource and energy exploitation, land use planning, waste disposal, and human modification of nature. Lecture, 2 units; laboratory and fieldwork, 1 unit. Intended for non-science majors.

### Course Attributes:

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

**ERTH 240 Environmental Water Resources (Units: 3)**

Apply concepts from hydrology, the science of water, to investigate the distribution, flow, and properties (physical, chemical, and biological) of water resources. Characterize the environmental state of freshwater and related food, energy, and ecological resources. Problem-solving related to pollution and prevention, natural disasters, such as droughts and floods, water scarcity, urbanization and stormwater, sustainable groundwater management, engineering solutions, seawater intrusion, and climate variability, with a focus on CA and San Francisco. Experience with hydrologic measurements, testing, data collection, and analysis in the field and using computer models. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

**Course Attributes:**

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

**ERTH 260 Physical Processes in the Atmosphere (Units: 4)**

Prerequisite: MATH 199 or equivalent or satisfactory score on calculus pretest.

Observed behaviors of the atmosphere and the processes and principles that explain and predict them. Algebra-based problem solving. Lecture, 3 units; laboratory, 1 unit. Extra fee required.

**Course Attributes:**

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability
- Global Perspectives

**ERTH 310 The Violent Earth (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better or permission of the instructor.

The catastrophic geological agents that modify the environment. The significance of processes such as earthquakes and volcanic eruptions in the development of our planet. The concept of time in evaluating the magnitude of these violent events. Designed for non-science majors.

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**ERTH 325 Geology of the National Parks (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better or permission of the instructor.

Apply geologic principles to natural environments of North America with a focus on the geologic history, landscape evolution of the National Parks, and the uniqueness of natural regions and questions of preservation. Lecture, 2 units; laboratory, 1 unit. Designed for non-science majors. (Plus-minus letter grade only)

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**ERTH 330 California Water (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better or permission of the instructor. Intended for non-science majors.

Human interaction with the hydrologic environment; science and politics of water issues facing California; hydrologic cycle, floods, droughts, groundwater, contamination; water needs of cities, farms, ecosystems; effects of climate change on water resources. (Plus-minus letter grade only)

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**ERTH 335 Global Warming (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better or permission of the instructor.

Scientific understanding of global warming. Greenhouse gases, records of past climate change, warming of the recent past, human impact on climate, projections of future climate, and the impact on society. Critical evaluation of popular media coverage of climate change.

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability
- Global Perspectives

**ERTH 360 California Weather Events (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better or permission of the instructor.

Investigation of the basic meteorology of normal and abnormal weather events in California.

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability
- Global Perspectives

**ERTH 365 Extreme Weather in a Warming World (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better or permission of the instructor.

Atmosphere and ocean as agents of catastrophic change. Fluctuations in atmospheric and oceanic circulations and their environmental impacts. Implications of human modification of the ocean-atmosphere system. Weather variability as evidenced by recent floods, droughts, and severe weather. Designed for non-science majors.

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability
- Global Perspectives

**ERTH 400 Earth Systems I (Units: 3)**

Prerequisites: At least 9 units of coursework in geoscience, earth sciences, chemistry, or physics.

Exploring the components of Earth's systems: atmosphere, hydrosphere, lithosphere, biosphere, and anthroposphere, with focus on the physical and biogeochemical processes through which the components interact. Lecture, 2 units; laboratory, 1 unit.

**ERTH 410 Volcanology (Units: 3)**

Prerequisite: ERTH 210 or permission of the instructor.

Volcanic processes, landforms, structures, and rocks; origin and differentiation of magma and relation to plate boundaries; case studies of volcanic events on earth and other planets; applications to archaeology and other disciplines. Lecture, 2 units; laboratory and fieldwork, 1 unit.

**ERTH 420 Mineralogy and Petrology I (Units: 4)**

Prerequisites: ERTH 210 and CHEM 115 or permission of the instructor.

Minerals: physical properties, crystal chemistry, reactions and stability, and identification of common types, including optical mineralogy. Lecture, 2 units; laboratory and fieldwork, 2 units.

**ERTH 425 Geomorphology (Units: 2)**

Prerequisites for ERTH 825: Graduate or senior standing; ERTH 210, ERTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222; or permission of the instructor.

Prerequisites for ERTH 425: Upper-division standing; ERTH 210, ERTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222; or permission of the instructor.

Landscapes, their geologic evolution, and the processes which create and modify them. Lecture, 3 units; laboratory, 1 unit.

(ERTH 825/ERTH 425 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 434 Coastal Processes (Units: 3)**

Prerequisites for ERTH 834: Graduate or senior standing; MATH 226 and PHYS 111 or PHYS 220; GPA of 3.0 or higher; or permission of the instructor.

Prerequisites for ERTH 434: Upper-division standing; MATH 226 and PHYS 111 or PHYS 220; GPA of 3.0 or higher; or permission of the instructor.

Dynamics of the nearshore ocean and interactions with the coast and beaches. Topics include tides, coastal waves and currents, sediment transport and beaches, inner shelf processes, and estuarine dynamics. Lecture, 2 units; laboratory, 1 unit.

(ERTH 834/ERTH 434 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 442 Surface Water Hydrology (Units: 4)**

Prerequisites: MATH 226 and ERTH 210 or ERTH 505 are recommended; or permission of the instructor.

Introduction to surface water hydrology; exploration of hydrologic processes; how precipitation and snowmelt become streamflow, evapotranspiration, and groundwater; watershed hydrology, streamflow processes, and water quality. Lecture, 3 units; activity, 1 unit. (Plus-minus letter grade only)

(This course is offered as ERTH 442 and GEOG 342. Students may not repeat the course under an alternate prefix.)

**ERTH 444 Hydrogeology (Units: 4)**

Prerequisites for ERTH 744: Graduate or senior standing; ERTH 210, ERTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222 or an upper-division Engineering course; or permission of the instructor.

Prerequisites for ERTH 444: Upper-division standing; ERTH 210, ERTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222; GPA of 3.0 or higher; or permission of the instructor.

Physical and geologic factors controlling the occurrence and dynamics of groundwater. Chemical parameters and distribution. Aquifer testing and analysis. Lecture, 3 units; laboratory, 1 unit.

(ERTH 744/ERTH 444 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 446 Quaternary Geology and Soils (Units: 3)**

Prerequisites for ERTH 846: Graduate standing; ERTH 210; or permission of the instructor.

Prerequisites for ERTH 446: Senior standing; ERTH 210; GPA of 3.0 or higher; or permission of the instructor.

Pleistocene and Holocene environments, and their geomorphic and stratigraphic record. Emphasis on landform evolution, soil genesis, soil genesis, climatic history, sea-level changes, neotectonics, and environmental impact. Lecture, 2 units; laboratory, 1 unit.

(ERTH 846/ERTH 446 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 465 Weather Analysis and Forecasting I (Units: 4)**

Prerequisites: ERTH 260, ERTH 461, MATH 227, PHYS 111 or (recommended) PHYS 220.

Weather analysis and forecasting as an application of the principles of atmospheric physics and dynamics. Weather satellite analysis techniques. Operational forecasting. Lecture, 2 units; laboratory, 2 units. (Plus-minus letter grade only)

**ERTH 470 Physical Oceanography (Units: 4)**

Prerequisites for ERTH 870: Graduate or senior standing; ERTH 170 or ERTH 172; and PHYS 220; or permission of the instructor.

Prerequisites for ERTH 470: Upper-division standing; ERTH 170 or ERTH 172; and PHYS 220; GPA of 3.0 or higher; or permission of the instructor.

The dynamic character of the ocean environment with an emphasis on the properties of seawater, surface heat transfer, Coriolis force, surface and deep ocean circulation, deep and shallow wave phenomena, and underwater sound and optics. Designed for both the physical scientist and marine biologist. Lecture, 3 units; laboratory, 1 unit.

(ERTH 870/ERTH 470 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 490 Public Weather Forecasting (Units: 1-3)**

Prerequisites: Earth Sciences majors; ERTH 160 or ERTH 162 or ERTH 260.

Weather forecasting tailored for public use. Forecasting and nowcasting in the media. Weather briefing duties of intern forecaster. May be repeated for a total of 3 units. (Plus-minus letter grade only)

**ERTH 500 Earth Systems II (Units: 3)**

Prerequisite: EARTH 400.

Exploration of how physical and biochemical processes in Earth's systems led to the origin and evolution of the continents, oceans, atmosphere, and life through geologic time. Lecture, 2 units; laboratory and fieldwork, 1 unit.

**ERTH 505 Quantitative Methods in Earth Sciences (Units: 3)**

Prerequisites: EARTH 400 or MATH 199.

Quantitative reasoning and techniques, including statistics, applied to problems in earth science. Lecture, 2 units; laboratory and fieldwork, 1 unit. Weekend field trip required. (Plus-minus letter grade only)

**ERTH 510 Structural Geology (Units: 2)**

Prerequisites: EARTH 500 and EARTH 420; EARTH 505 or MATH 199.

Mechanical aspects of rock deformation. Description, classification, and genesis of folds, faults, and other structures of the earth's crust. Evolution of regional structures. Lecture, 2 units; laboratory and fieldwork, 2 units.

**ERTH 515 Sedimentology and Stratigraphy (Units: 4)**

Prerequisites: EARTH 205, EARTH 420, and EARTH 500.

Sedimentary particles and processes, depositional environments, principles of stratigraphic correlation, and basin analysis. Lecture, 2 units; laboratory and fieldwork, 2 units. (Plus/minus letter grade only)

**ERTH 520 Mineralogy and Petrology II (Units: 4)**

Prerequisite for EARTH 820: Graduate standing or permission of the instructor.

Prerequisites for EARTH 520: Upper-division standing; EARTH 420; GPA of 3.0 or higher; or permission of the instructor.

Advanced mineralogy and igneous and metamorphic petrology with a focus on physical and chemical processes in the earth. Lecture, 2 units; laboratory, 2 units. Extra fee required.

(ERTH 820/ERTH 520 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 526 Ore Deposits (Units: 4)**

Prerequisite for EARTH 826: Graduate standing; EARTH 420; or permission of the instructor.

Prerequisites for EARTH 526: Upper-division standing; EARTH 420; GPA of 3.0 or higher; or permission of the instructor.

The origin of ore deposits emphasizing the mineralogic, petrologic, and plate tectonic environments of major deposits from around the world. Chemical and physical controls on ore transport and deposition. Techniques of mineral exploration and mining. Lecture, 3 units; laboratory, 1 unit.

(ERTH 826/ERTH 526 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 535 Planetary Climate Change (Units: 3)**

Prerequisites: At least 9 units of physical sciences coursework.

Interdisciplinary investigation of physical processes, principles, and tools contributing to our understanding of climate and climate change. Lecture, 3 units; laboratory, 1 unit.

**ERTH 544 Groundwater Contamination (Units: 3)**

Prerequisites for EARTH 844: Graduate or senior standing; EARTH 744.

Prerequisites for EARTH 544: Upper-division standing; EARTH 444; CHEM 115 recommended; GPA of 3.0 or higher; or permission of the instructor.

Application of hydrogeologic principles to the solution of groundwater contamination problems. Seminar, 2 units; laboratory, 1 unit. (ERTH 844/ERTH 544 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 577 Climate and Ecological Interactions (Units: 4)**

Prerequisites: MATH 107 and MATH 108, or MATH 199, or MATH 226; BIOL 230 and BIOL 240 or two 200-level or higher courses in Earth & Climate Sciences; or permission of the instructor.

Theory, observations, and modeling of the two-way interaction between climate and ecology. Lecture, 3 units; laboratory, 1 unit. (Plus-minus letter grade only)

(This course is offered as BIOL 577 and EARTH 577. Students may not repeat the course under an alternate prefix.)

**ERTH 600GW Earth's Climate History - GVAR (Units: 3)**

Prerequisites: GE Area A2; CHEM 115 and EARTH 500 (may be taken concurrently).

Examination of Earth's climate history over the last 50 million years; analysis of different mechanisms of climate forcing including tectonic changes, greenhouse gas forcing on long and short time scales, orbital forcing, and internal climate feedback. Lecture, 2 units; laboratory, 1 unit. (ABC/NC grading only)

**Course Attributes:**

- Graduation Writing Assessment

**ERTH 610 Neotectonics (Units: 3)**

Prerequisites for EARTH 810: Graduate or senior standing; EARTH 510; or permission of the instructor.

Prerequisites for EARTH 610: Senior standing; EARTH 510; GPA of 3.0 or higher; or permission of the instructor.

Principles of earthquake geology including plate tectonics, fault mechanics, basic seismology, geodesy, tectonic geomorphology, seismic hazard analysis, and case studies of large historical earthquakes. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

(ERTH 810/ERTH 610 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 620 Field Methods in Geology (Units: 2)**

Prerequisites: EARTH 210, EARTH 510, EARTH 515, satisfactory standing in the major, or permission of the instructor.

Field methods: plotting features on topographic maps and aerial photographs, use of field instruments, mapping, and preparation of geologic reports. Laboratory and fieldwork.

**ERTH 642 Watershed Assessment and Restoration (Units: 4)**

Prerequisites: GEOG 101 or EARTH 210; GEOG 603 and MATH 199.

Assessing and restoring watersheds and streams. Exploration of hydrologic and watershed processes, variables influencing runoff and erosion, and hillslope and stream restoration techniques. Lecture, 3 units; activity, 1 unit. [CSL may be available]

(This course is offered as GEOG 642 and EARTH 642. Students may not repeat the course under an alternate prefix.)

**ERTH 690 Earth Sciences Capstone Presentation (Unit: 1)**

Prerequisites: Restricted to senior Earth Sciences majors, ERTH 695 or ERTH 698 (may be taken concurrently).

Principles and best practices of presenting scientific information orally and by poster. Practice presenting senior project or senior thesis research. Presentation of senior project at a poster session or oral thesis defense open to the public. (Plus-minus letter grade only)

**ERTH 695 Senior Project (Units: 1-3)**

Prerequisites: Senior Earth Sciences majors, 3.0 GPA in major course work, and permission of Earth Sciences faculty adviser.

Directed, original research on an Earth Sciences-related problem.

**ERTH 697 Undergraduate Research (Units: 2)**

Prerequisites: Senior standing and permission of the instructor.

Research activities, including literature review, project design, data collection, and analysis. (Plus-minus letter grade only)

**ERTH 698 Senior Thesis (Units: 2)**

Prerequisite: ERTH 697 (may be taken concurrently).

Undergraduate research, to include a written report and oral presentation approved by the thesis committee. (Plus-minus letter grade only)

**ERTH 699 Independent Study (Units: 1-3)**

Prerequisite: Permission of the instructor.

Independent study in the laboratory, field, or library under the direction of a faculty member. The student must present a written report of the work accomplished to the faculty.

**ERTH 700 Graduate Seminar in Geosciences (Units: 2)**

Prerequisite: Graduate standing.

Introduction to the graduate program; discussion of interdisciplinary geoscience topics; format to include speakers and assigned readings. (Plus-minus letter grade only)

**ERTH 701 Research Methods in Geosciences (Units: 3)**

Prerequisite: ERTH 700 or permission of the instructor.

Application of research methods: problem formulation, literature searches, proposal writing, scientific report writing, and oral presentation. Preparation of proposal for master's thesis. (Plus-minus letter grade only)

**ERTH 702 Quantitative Methods in Geosciences (Units: 3)**

Prerequisites: Courses in basic statistics, calculus, and computer applications, or permission of the instructor.

Quantitative methods and computer techniques necessary for geoscience problem-solving. Lecture, 2 units; laboratory and fieldwork, 1 unit. (Plus-minus letter grade only)

**ERTH 741 Electron Microscopy (Units: 4)**

Prerequisites: Graduate or senior standing and permission of the instructor.

Introduction to electron microscopy with a focus on instrumentation, image formation and interpretation, x-ray microanalysis, sample preparation, artifacts, and related techniques. Laboratory work includes operation of the electron microscope, x-ray microanalysis, and the preparation of biological and inorganic specimens for scanning and transmission electron microscopy. Seminar, 2 units; laboratory, 2 units. Extra fee required. (Plus-minus letter grade only)  
(This course is offered as BIOL 741, CHEM 741, and ERTH 741. Students may not repeat the course under an alternate prefix.)

**ERTH 744 Hydrogeology (Units: 4)**

Prerequisites for ERTH 744: Graduate or senior standing; ERTH 210, ERTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222 or an upper-division Engineering course; or permission of the instructor.

Prerequisites for ERTH 444: Upper-division standing; ERTH 210, ERTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222; GPA of 3.0 or higher; or permission of the instructor.

Physical and geologic factors controlling the occurrence and dynamics of groundwater. Chemical parameters and distribution. Aquifer testing and analysis. Lecture, 3 units; laboratory, 1 unit.

(ERTH 744/ERTH 444 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 790 Advanced Public Weather Forecasting (Units: 1-3)**

Prerequisite: ERTH 490 and/or permission of the instructor.

Direction of a forecast office. Students assume lead forecaster responsibilities in administration of the SF State Public Weather Forecast Center. (Plus-minus letter grade only)

**ERTH 795 Selected Topics in the Geosciences (Units: 3)**

Prerequisite: Graduate standing or permission of the instructor.

Topics to be specified in the Class Schedule. May be repeated for a maximum of 12 units when topics vary. (Plus-minus letter grade only)

**Topics:**

- a. Rock Mechanics in Geomorphology
- b. Sedimentary Processes & Depositional Environments
- c. Vadose Zone Hydrology
- d. Global Tectonics
- e. Oceanographic Processes in the CA Current System

**ERTH 810 Neotectonics (Units: 3)**

Prerequisites for ERTH 810: Graduate or senior standing; ERTH 510; or permission of the instructor.

Prerequisites for ERTH 610: Senior standing; ERTH 510; GPA of 3.0 or higher; or permission of the instructor.

Principles of earthquake geology including plate tectonics, fault mechanics, basic seismology, geodesy, tectonic geomorphology, seismic hazard analysis, and case studies of large historical earthquakes. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

(ERTH 810/ERTH 610 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 820 Mineralogy and Petrology II (Units: 4)**

Prerequisite for ERTH 820: Graduate standing or permission of the instructor.

Prerequisites for ERTH 520: Upper-division standing; ERTH 420; GPA of 3.0 or higher; or permission of the instructor.

Advanced mineralogy and igneous and metamorphic petrology with a focus on physical and chemical processes in the earth. Lecture, 2 units; laboratory, 2 units. Extra fee required.

(ERTH 820/ERTH 520 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)



**ERTH 825 Geomorphology (Units: 4)**

Prerequisites for EARTH 825: Graduate or senior standing; EARTH 210, EARTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222; or permission of the instructor.

Prerequisites for EARTH 425: Upper-division standing; EARTH 210, EARTH 505 or MATH 226, and PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222; or permission of the instructor.

Landscapes, their geologic evolution, and the processes which create and modify them. Lecture, 3 units; laboratory, 1 unit.

(ERTH 825/ERTH 425 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 826 Ore Deposits (Units: 4)**

Prerequisite for EARTH 826: Graduate standing; EARTH 420; or permission of the instructor.

Prerequisites for EARTH 526: Upper-division standing; EARTH 420; GPA of 3.0 or higher; or permission of the instructor.

The origin of ore deposits emphasizing the mineralogic, petrologic, and plate tectonic environments of major deposits from around the world. Chemical and physical controls on ore transport and deposition. Techniques of mineral exploration and mining. Lecture, 3 units; laboratory, 1 unit.

(ERTH 826/ERTH 526 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 834 Coastal Processes (Units: 3)**

Prerequisites for EARTH 834: Graduate or senior standing; MATH 226 and PHYS 111 or PHYS 220; GPA of 3.0 or higher; or permission of the instructor.

Prerequisites for EARTH 434: Upper-division standing; MATH 226 and PHYS 111 or PHYS 220; GPA of 3.0 or higher; or permission of the instructor.

Dynamics of the nearshore ocean and interactions with the coast and beaches. Topics include tides, coastal waves and currents, sediment transport and beaches, inner shelf processes, and estuarine dynamics. Lecture, 2 units; laboratory, 1 unit.

(ERTH 834/ERTH 434 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 844 Groundwater Contamination (Units: 3)**

Prerequisites for EARTH 844: Graduate or senior standing; EARTH 744.

Prerequisites for EARTH 544: Upper-division standing; EARTH 444; CHEM 115 recommended; GPA of 3.0 or higher; or permission of the instructor.

Application of hydrogeologic principles to the solution of groundwater contamination problems. Seminar, 2 units; laboratory, 1 unit.

(ERTH 844/ERTH 544 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 846 Quaternary Geology and Soils (Units: 3)**

Prerequisites for EARTH 846: Graduate standing; EARTH 210; or permission of the instructor.

Prerequisites for EARTH 446: Senior standing; EARTH 210; GPA of 3.0 or higher; or permission of the instructor.

Pleistocene and Holocene environments, and their geomorphic and stratigraphic record. Emphasis on landform evolution, soil genesis, soil genesis, climatic history, sea-level changes, neotectonics, and environmental impact. Lecture, 2 units; laboratory, 1 unit.

(ERTH 846/ERTH 446 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 870 Physical Oceanography (Units: 4)**

Prerequisites for EARTH 870: Graduate or senior standing; EARTH 170 or EARTH 172; and PHYS 220; or permission of the instructor.

Prerequisites for EARTH 470: Upper-division standing; EARTH 170 or EARTH 172; and PHYS 220; GPA of 3.0 or higher; or permission of the instructor.

The dynamic character of the ocean environment with an emphasis on the properties of seawater, surface heat transfer, Coriolis force, surface and deep ocean circulation, deep and shallow wave phenomena, and underwater sound and optics. Designed for both the physical scientist and marine biologist. Lecture, 3 units; laboratory, 1 unit.

(ERTH 870/ERTH 470 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 896 Directed Reading in the Geosciences (Units: 3)**

Prerequisite: Graduate status or permission of adviser.

Supervised literature research in a specific area chosen on the basis of individual student need. Readings, tutorial discussion, and research report or creative projects. May be repeated for a total of 6 units. (Plus-minus letter grade, RP grading only)

**ERTH 897 Research Project (Units: 1-3)**

Prerequisites: Graduate standing, EARTH 700, and EARTH 701.

Thesis research incorporates all aspects of investigative studies from data collection to data analysis. May be repeated for a total of 6 units. (Plus-minus letter grade, RP grading only)

**ERTH 898 Master's Thesis (Units: 3)**

Prerequisites: Graduate standing, EARTH 700, EARTH 701, EARTH 702, permission of instructor and approval of Advancement to Candidacy (ATC) and Culminating Experience (CE) forms by Graduate Studies.

Advancement to Candidacy (ATC) and Proposal for Culminating Experience Requirement forms must be approved by the Graduate Division before registration. (Plus-minus letter grade, RP grading only)

**ERTH 899 Independent Study (Units: 1-3)**

Prerequisites: Graduate standing and permission of the adviser.

Independent study in the laboratory or field under the direction of a faculty member. A detailed written report of the work accomplished must be submitted to the department. May be repeated for a total of 6 units. (Plus-minus AB/NC grading only)